CHAPTER 1

WATER QUALITY ASSESSMENT OF RIVERS AND STREAMS

WATER QUALITY ASSESSMENT
RIVERS AND STREAMS

Status

Water quality conditions for rivers and streams in Kentucky are summarized by use support status in Table 1. The table indicates that of the 9,380.4 miles assessed, approximately 34 percent experienced some degree of use impairment, while 66 percent fully supported uses. River basin maps displaying use support information are presented in Figures 1 through 8. Approximately 50 percent of the river miles on the U.S.G.S. hydrologic unit maps were assessed. This is a 20 percent increase in map miles covered and is 40 percent more than the miles assessed in the 1986 305(b) report.

Table 1

Designated Use Support by River Basin

Basin	Total Miles	Miles Assessed	Miles Fully Supporting Use(s)	Miles Partially Supporting Use(s)	Miles Not Supporting Use(s)
Big Sandy	1,247.8	429.3	221.4	53.6	154.3
Little Sandy	360.2	122.9	41.2	31.1	50.6
Tygarts Creek	194.4	192.9	145.4	2.0	45.5
Licking	1,993.0	654.2	429.6	28.0	196.6
Kentucky	3,442.7	1,598.9	1,072.7	53.6	472.6
Upper Cumberland	2,089.2	952.7	715.8	152.2	84.7
Salt	1,528.7	889.8	529.1	144.0	216.7
Green	3,499.3	2,335.8	1,944.3	155.4	236.1
Tradewater	514.9	323.2	135.4	102.0	85.8
Lower Cumberland	672.9	404.1	329.1	68.0	7.0
Tennessee	368.6	142.5	101.5	21.5	19.5
Mississippi	440.1	214.1	96.5	95.8	21.8
Ohio (Minor tribs)	1,449.2	456.1	413.2	35.3	7.6
Ohio (Mainstem)*	663.9	663.9	0.0	540.1	123.8
STATE TOTAL	18,464.9	9,380.4	6,175.2	1,482.6	1,722.6

*Assessment provided in 1988 ORSANCO 305(b) Report.

Methods of Assessment

Water quality data collected by the Kentucky Division of Water, Kentucky Division of Waste Management, Ohio River Valley Sanitation Commission, U.S. Army Corps of Engineers, Virginia State Water Control Board, and the U.S. Geological Survey were used to determine stream use support status. Other sources of information used in this determination include biological studies at fixed stations,

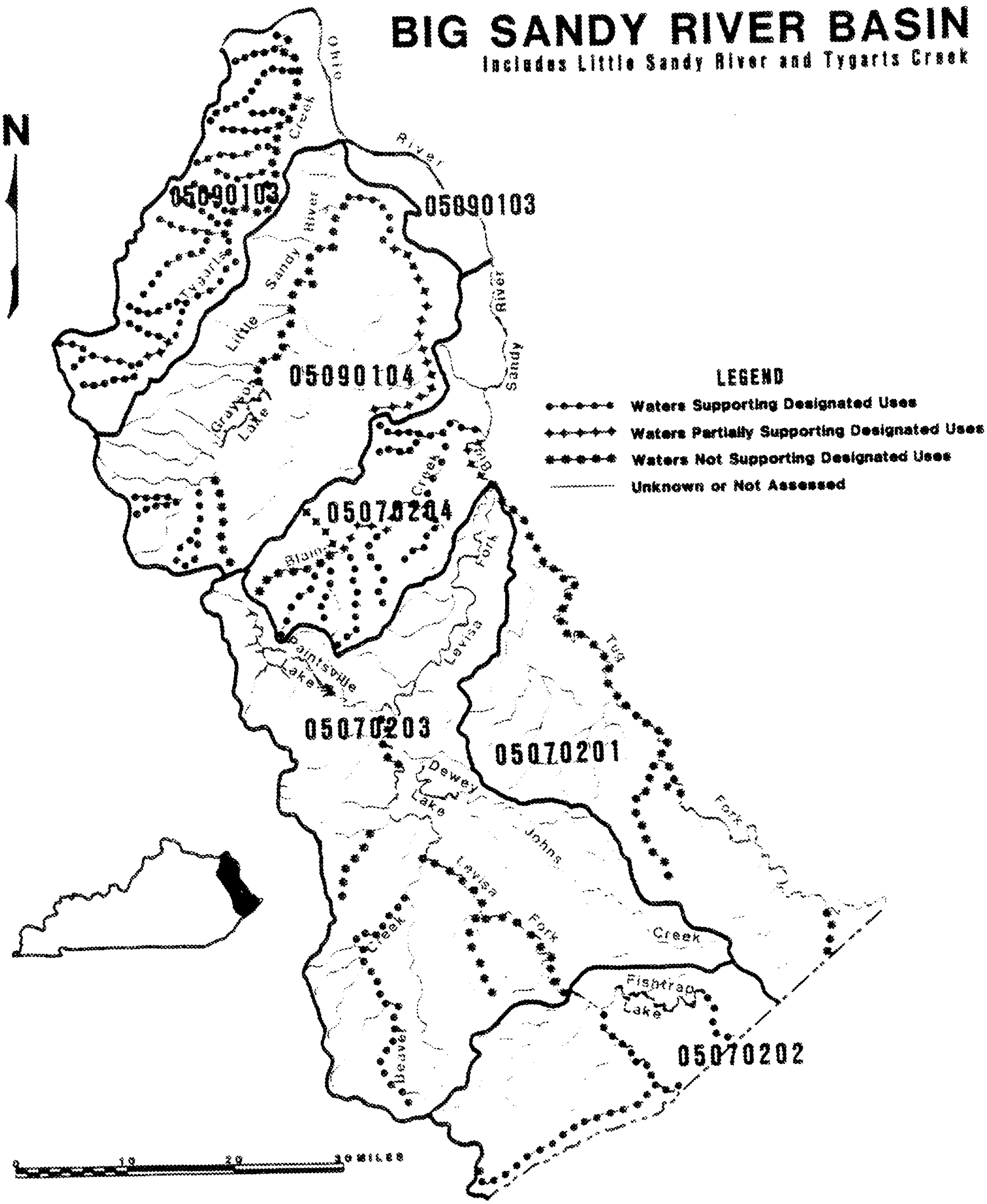
BIG SANDY RIVER BASIN
Includes Little Sandy River and Tygarts Creek
N
LEGEND
Waters Supporting Designated Uses
Waters Partially Supporting Designated Uses
Waters Not Supporting Designated Uses
Unknown or Not Assessed
Ohio River
Tygarts Creek
Little Sandy River
Big Sandy River
Grayson Lake
Blaine Creek
Paintsville Lake
Levisa Fork
Tug Fork
Dewey Lake
Johns Creek
Beaver Creek
Fishtrap Lake
05090103
05090103
05090104
05070204
05070203
05070201
05070202
0
10
20
30 MILES

Figure 1

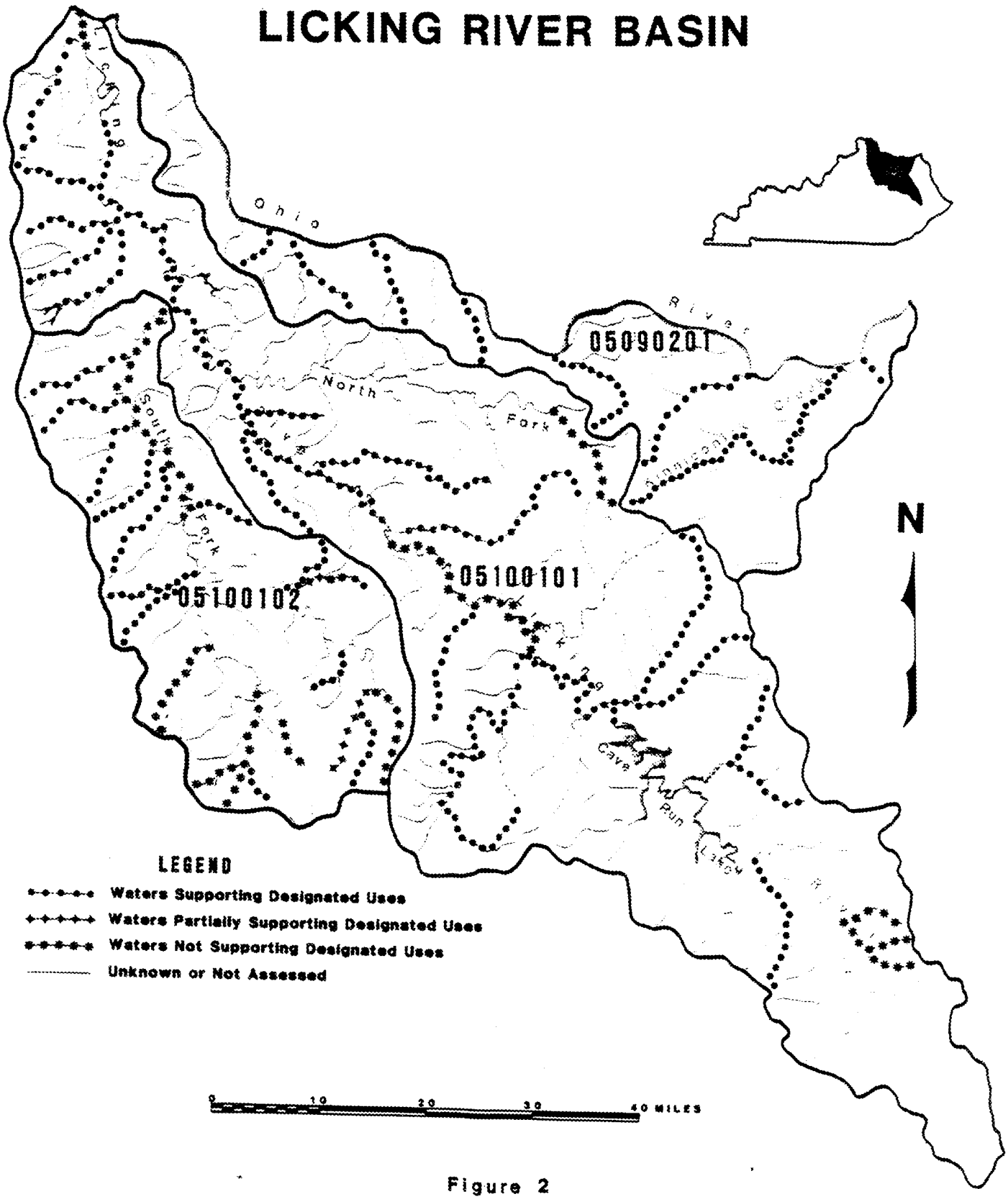
LICKING RIVER BASIN
Ohio
North Fork
South Fork
05090201
05100101
05100102
N
LEGEND
Waters Supporting Designated Uses
Waters Partially Supporting Designated Uses
Waters Not Supporting Designated Uses
Unknown or Not Assessed
0 10 20 30 40 MILES

Figure 2

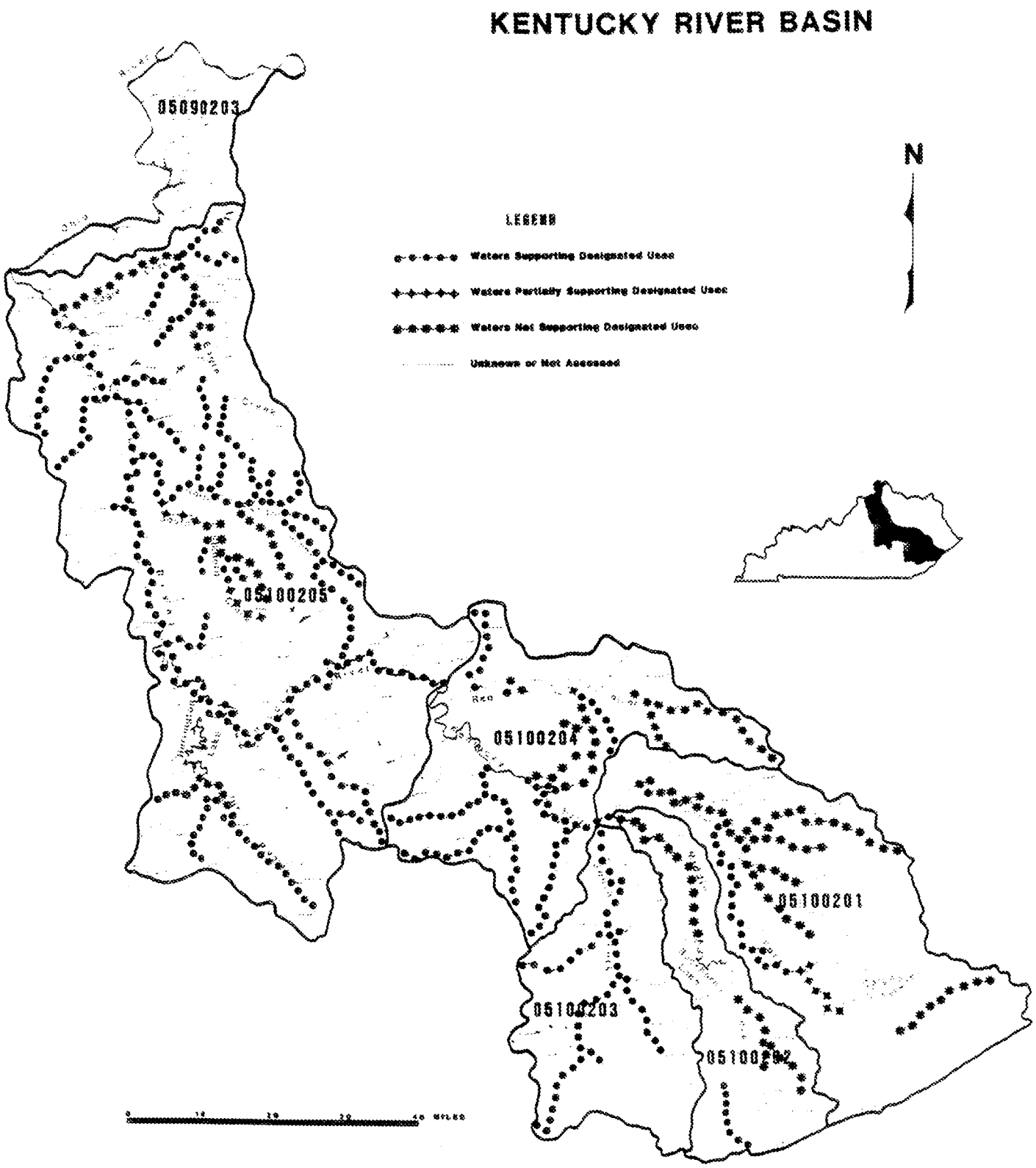
KENTUCKY RIVER BASIN
05090203
N
LEGEND
Waters Supporting Designated Uses
Waters Partially Supporting Designated Uses
Waters Not Supporting Designated Uses
Unknown or Not Assessed
05100205
05100204
05100201
05100203
0 10 20 30 40 MILES

Figure 3

UPPER CUMBERLAND RIVER BASIN

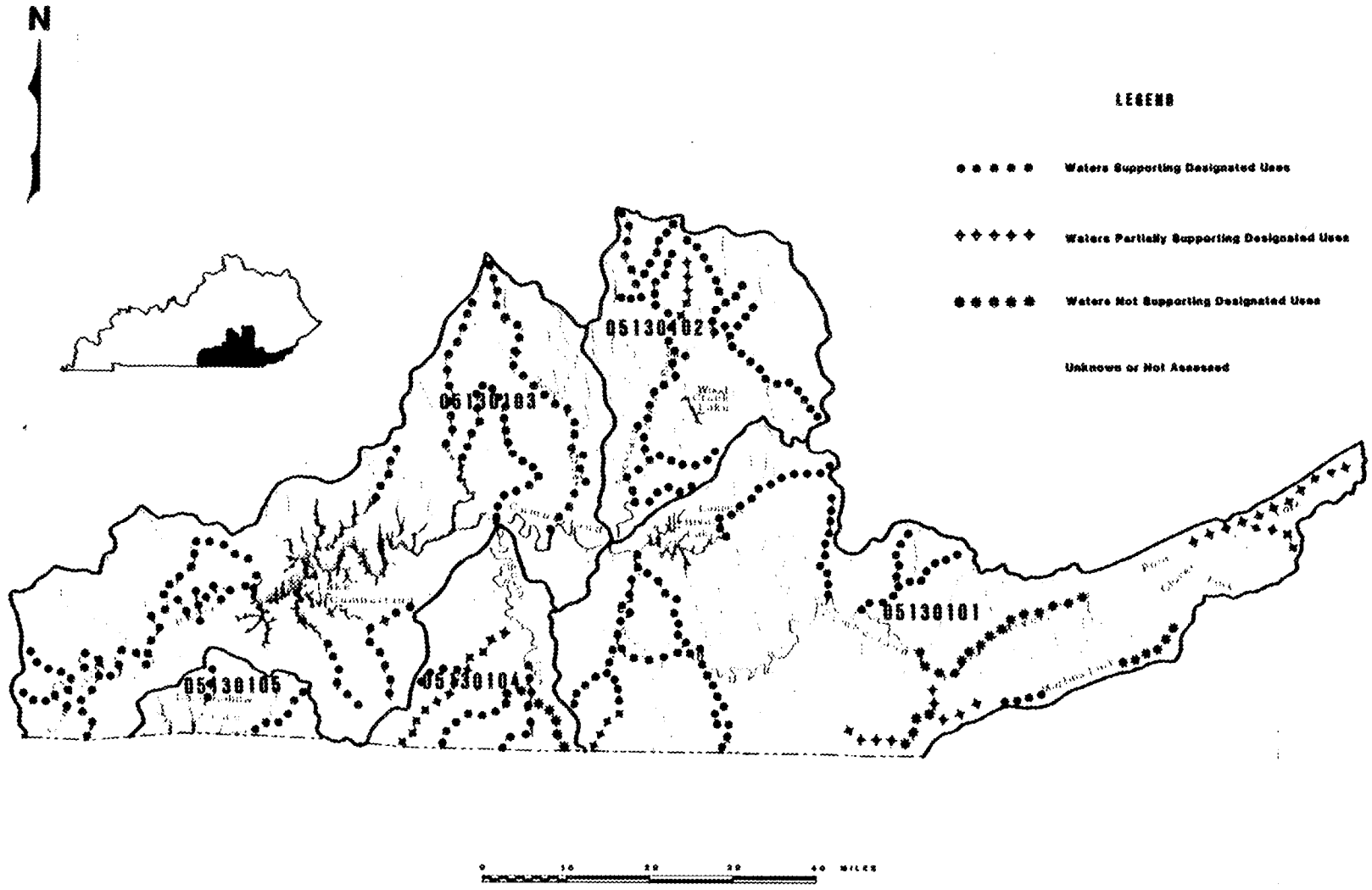

Figure 4

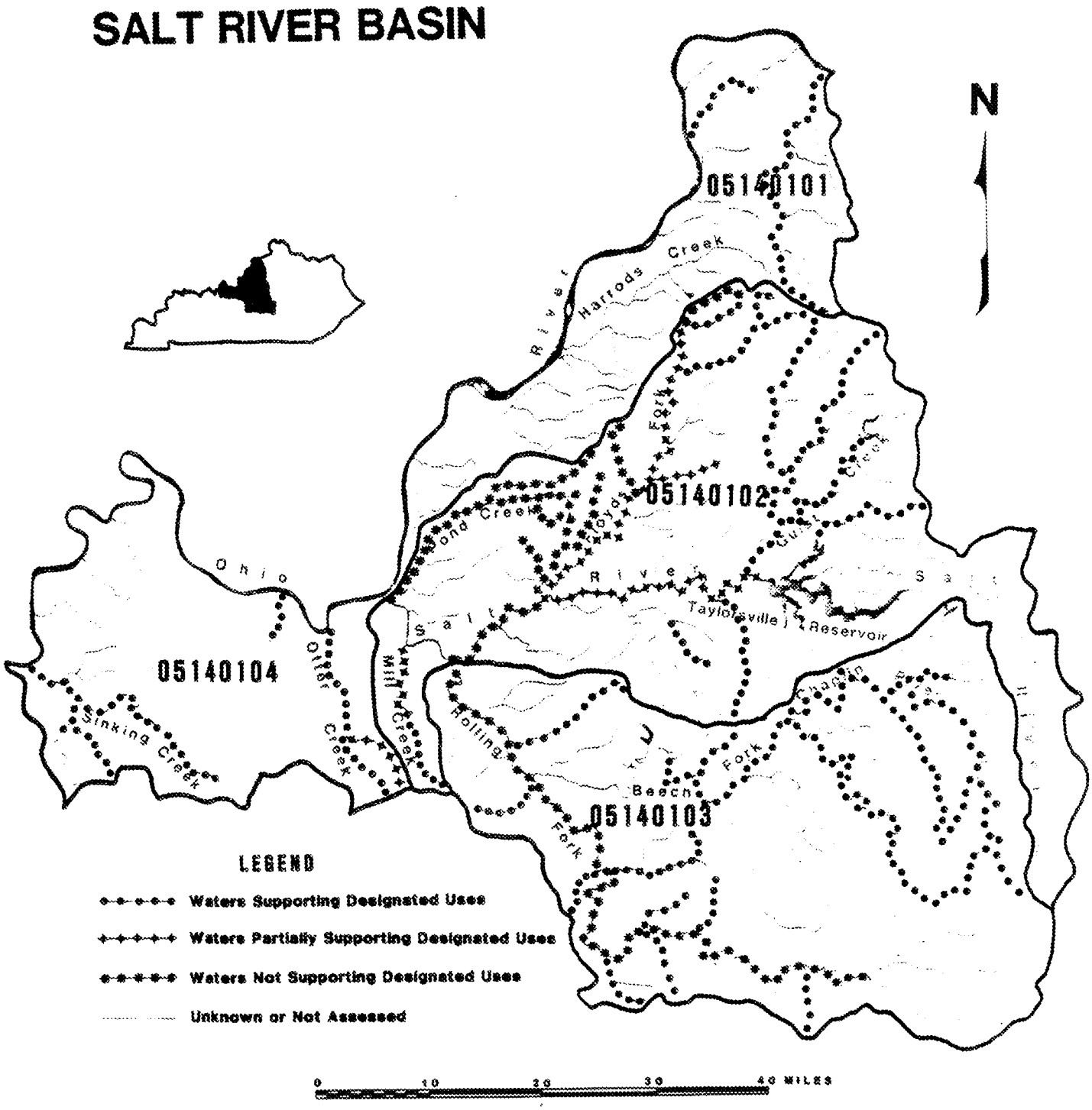
SALT RIVER BASIN
N
05140101
05140102
05140103
05140104
Harrods Creek
Floyds Fork
Bond Creek
Ohio
Otter Creek
Mill Creek
Sinking Creek
Rolling Fork
Beech Fork
Taylorsville Lake Reservoir
LEGEND
Waters Supporting Designated Uses
Waters Partially Supporting Designated Uses
Waters Not Supporting Designated Uses
Unknown or Not Assessed
0 10 20 30 40 MILES

Figure 5

GREEN RIVER BASIN

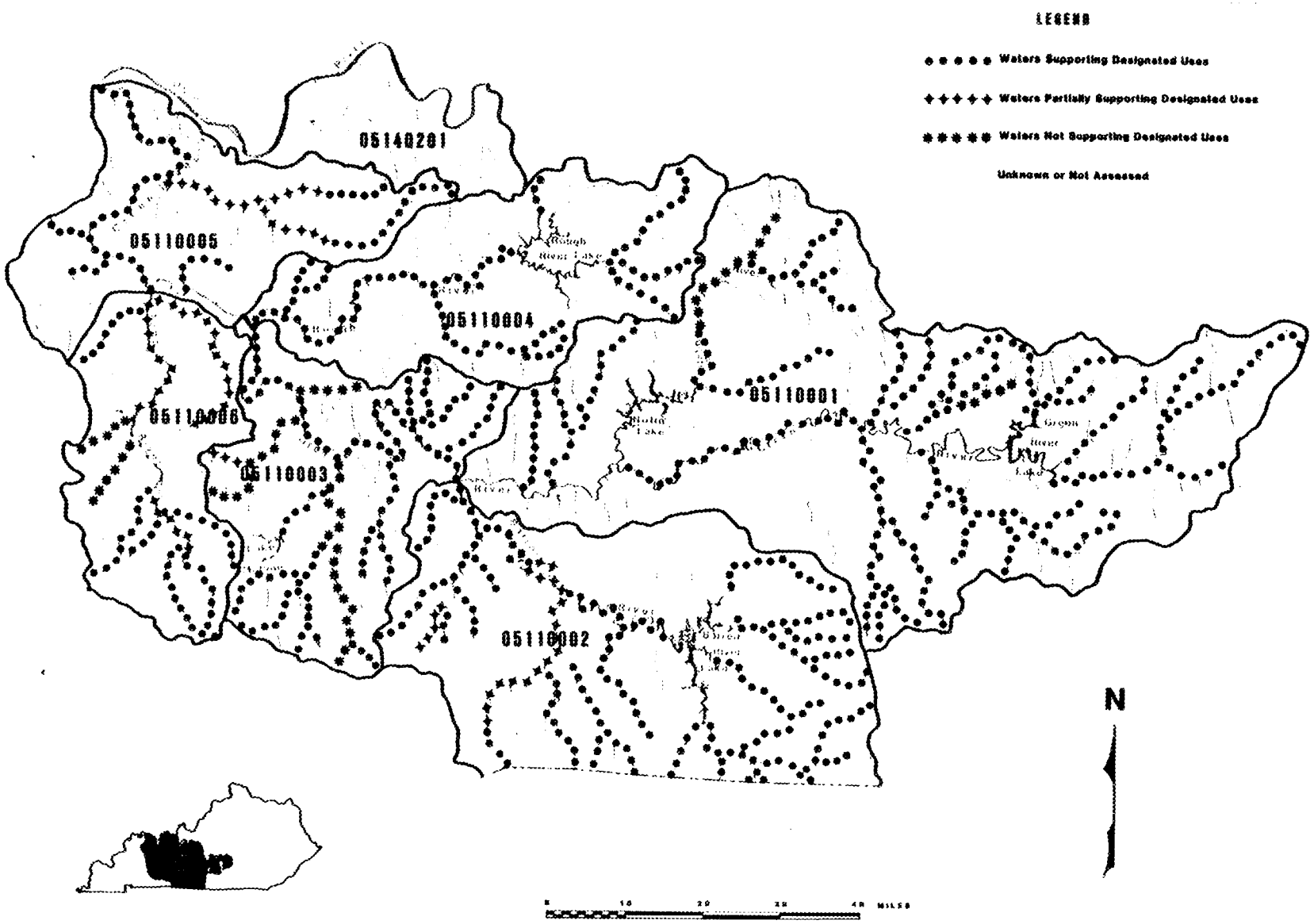

Figure 6

LOWER CUMBERLAND AND TRADEWATER RIVER BASINS

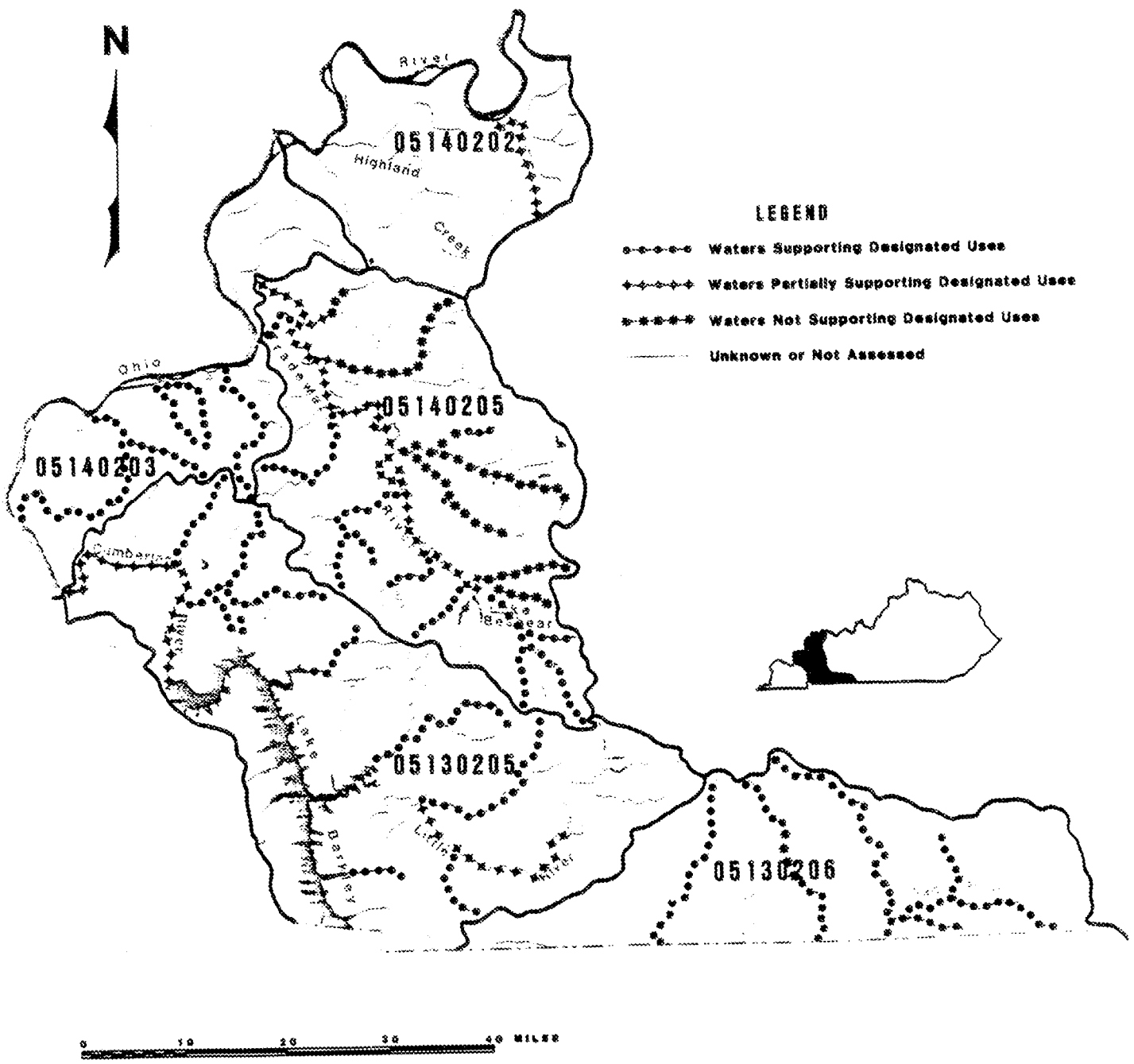

Figure 7

TENNESSEE AND MISSISSIPPI RIVER BASINS

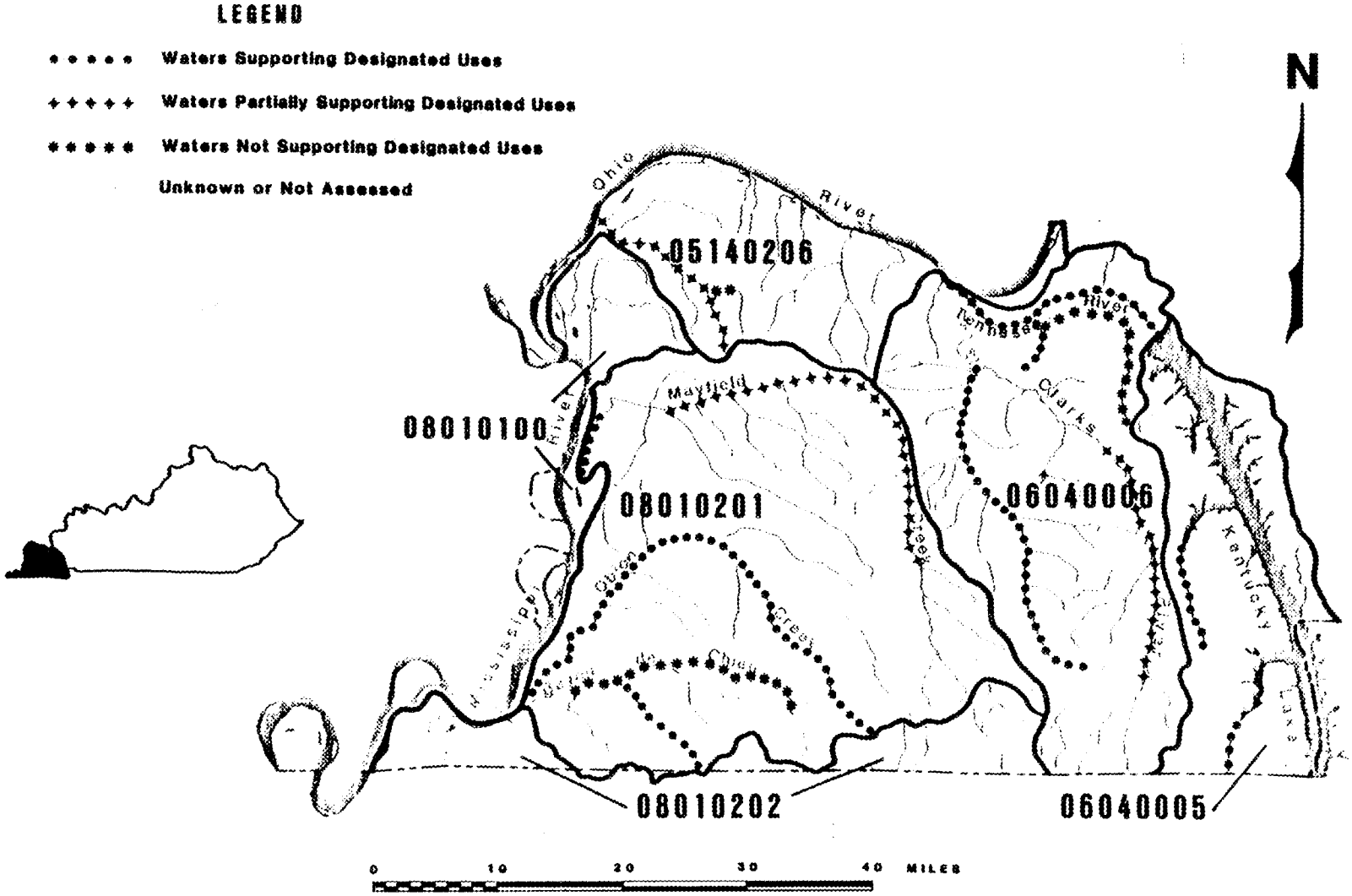

Figure 8

intensive surveys, and data supplied by the Kentucky Department of Fish and Wildlife Resources. The data were categorized as "monitored" or "evaluated." Monitored data were derived from site specific ambient surveys and were no more than five years old. Evaluated data were from other sources or from ambient surveys which were conducted more than five years ago. The criteria for assessing this data to determine use support follows.

Water Quality Data

Chemical data collected at fixed stations were evaluated according to U.S. EPA guidelines for the preparation of this report. Water quality data collected during the period from October 1985 through September 1987 were compared with state and EPA standards and applied to the status criteria. A list of the parameters and their corresponding criteria are noted in Table 2. All of the criteria in the table except fecal coliform were used to assess warmwater aquatic habitat (WAH) use support. If none of the criteria were exceeded in $\leq$ 10 percent of the measurements and their means were less than the criteria, the segment fully supported its use for WAH. Partial support was indicated if any one criterion was exceeded 11-25 percent of the time and the mean was less than the criterion, or if any criterion was exceeded $\leq$10 percent of the time and its mean was greater than the criterion. The segment was not supporting if any criterion was exceeded >25 percent of the time or the criterion was exceeded 11-15 percent of the time and the mean was greater than the criterion.

Fecal coliform data were used to indicate degree of support for primary and secondary contact recreation use. Primary contact support was indicated if the samples measured in May through October did not exceed 400 colonies/100 ml more than 20 percent of the time. If they did, the segment was judged not to support that use. Secondary contact recreation use was supported if (during the months of November through April) the samples measured in a segment did not exceed 2000 colonies/100 ml more than 20 percent of the time. If they did, the segment was judged to not support the use. Partial support was not assessed. Domestic water supply use was not assessed because the use is applicable at points of withdrawal only and could not be quantified in the format required by the guidelines. In areas where both chemical and biological data were available, the biological data were generally the determinate factor for establishing warmwater aquatic habitat use support status.

Fixed Station Biological Data

Biological data for 1984-1987 were collected from 33 fixed stations in ten drainage basins throughout the state. Algae, macroinvertebrates and fish were collected on an annual basis and used for making the biological assessments for those streams. The criteria used to evaluate each of those biological components varies according to habitat requirements, collection methods and stream characteristics. Once all data (algal, macroinvertebrate and fish) were compiled, a consensus was reached on use attainment. A reach was considered fully supporting the warmwater aquatic habitat use if all components showed full support. Partial or nonsupport was indicated if one or more of these components were not supporting the WAH use. A reach was classified as threatened when obvious habitat or water quality changes have occurred or have begun to occur because of increased sedimentation from upstream land disturbance or increased nutrient loading from nonpoint sources. These reaches may show use impairment in the future.

Because of the inherent variability in biological data caused by such factors as microhabitat differences at sites, habitat preferences of different species,

seasonal distributional patterns and/or site-specific physical characteristics, there are no set criteria by which to judge community structure values at all sites. It is necessary to carefully weigh all the data when the objective is to determine extent of

Table 2

Parameters and Criteria Used to Determine Use Support Status

Parameter	Criterion	Source
Dissolved oxygen	4.0 mg/l	KWQS[1]
Temperature	30°C	KWQS
pH	6 to 9 units	KWQS
Un-ionized ammonia	0.05 mg/l	KWQS
Chloride	250 mg/l	KWQS
Arsenic	50 ug/l	KWQS
Cadmium	4 ug/l soft water 12 ug/l hardwater	KWQS (hardness <75 mg/l)
Chromium	100 ug/l	KWQS
Copper	Based on hardness[2]	EPA[3]
Lead	Based on hardness[4]	EPA
Mercury	0.2 ug/l	KWQS
Zinc	47 ug/l	KWQS
Fecal coliform	(May 1 thru Oct. 31) 400 colonies/100 ml (Nov. 1 thru April 30) 2000 colonies/100 ml	KWQS

1) Kentucky Water Quality Standards
2) Criterion = e (.8545 ln x - 1.465) x = hardness in mg/l as $CaCO_3$
3) U.S. Environmental Protection Agency
4) Criterion = e (1.273 ln x - 4.705) x = hardness in mg/l as $CaCO_3$

use support. In some instances, mean values of various indices can be calculated from all monitoring stations, and comparisons can be made against this mean. In addition, other reference sites known to have high water quality, or data from previous collections at a site, may be used for comparison. A discussion of the assessment criteria for each of the biological components follows.

Algae Algal samples were collected from each biological monitoring station using standarized collection procedures. Both plankton (algae suspended in the water

column) and periphyton (attached algae) were collected. Plankton chlorophyll *a*, periphyton chlorophyll *a* and periphyton ash-free dry-weight were measured at each site, and diatoms were identified to species and enumerated. Diatom community structure indices (taxa richness, diversity and equitability) and relative abundance values were calculated.

Based on algal data, a reach supported the WAH use if the diatom taxa richness was high, community structure values were average or high, plankton and periphyton chlorophyll *a* and ash-free dry weight values were near average, and the diatom community was dominated by species typical for the particular physical characteristics and habitats present at the reach. A reach partially supported uses if diatom taxa richness was low, if community structure values were slightly lower than expected, or if the type of species present indicated a use impairment. Comparisons are based on other reference sites, average values for sites of similar physical and habitat characteristics, or values derived from the same site at a previous time. A reach did not support uses if toxic or organic enrichment was obvious based on the above-mentioned community structure criteria, or if the diatom community was dominated by pollution tolerant species. When chlorophyll *a* values were well above the mean, and taxa richness and diversity were low, organic pollution was indicated, while toxic impacts were suspected if taxa richness was extremely low compared to the mean value, but diversity and equitability values were average.

Macroinvertebrates For the macroinvertebrate evaluations, stream reaches were considered to fully support WAH use if information reflected no alterations in community structures or functional compositions for the available habitats, and if habitat conditions were relatively undisturbed. A reach was considered partially supporting uses when information revealed that community structures were slightly altered, that functional feeding components were noticeably influenced or if available habitats reflected some alterations and/or reductions. Reaches were considered not supporting uses if information reflected sustained alterations or deletions in community structures, taxa richness and functional feeding types, or if available habitats were often severely reduced or eliminated.

Fish Fish were collected for community structure evaluation at selected biological monitoring sites. The condition of the fish community was determined by analysis of relative abundance, species richness and species composition as well as use of an Index of Biotic Integrity (IBI). The IBI was used to assess biotic integrity directly by evaluation of twelve attributes, or community metrics, of fish communities in streams. These community metrics include measurement of species richness and composition, trophic structure, and fish abundance and condition. The IBI was used to assign one of the following categories to a fish community: excellent, good, fair, poor, very poor or no fish. Communities rated excellent or good indicated a reach as fully supporting, those rated fair indicated a reach as partially supporting, and those rated poor, very poor or no fish indicated a reach as not supporting the WAH use.

Intensive Survey Data

During 1986-1987, four intensive surveys were conducted to determine if streams were supporting their designated uses. In addition, data were evaluated from 32 surveys conducted during 1982-1985. About 50 percent of the total stream miles assessed by these surveys were considered as evaluated because the data were greater than five years old or not specific enough in quality to be used in the monitored category. The remaining miles were considered as monitored (those waterbodies for which the assessment is based on site specific ambient data less than five years old).

The streams were assessed by evaluating the biological, physicochemical, toxicological and habitat data and known watershed activities in concert with direct observation and professional judgment. The stream mileages were grouped as supporting, partially supporting, or nonsupporting uses. The streams were considered to support designated uses if no impacts or only minor impacts to the biotic integrity, physical habitat and water quality were observed. Streams were determined to be partially supporting when the data indicated stressed biotic communities, minor violations of water quality criteria or some physical impairment to aquatic habitats. Nonsupporting streams were those indicating severe stress, such as sustained species deletions, trophic imbalances in the biotic communities, chronic violations of water quality criteria and severely reduced or eliminated aquatic habitats.

Kentucky Department of Fish and Wildlife Resources Data

The Division of Water extended its analysis of stream use support by developing questionnaires on unmonitored streams and sending them to Conservation Officers of the Kentucky Department of Fish and Wildlife Resources (KDFWR). The questionnaire results were utilized in the evaluated category of assessed waters. Sixty-six of 120 questionnaires were returned, a response of slightly over 50 percent.

Each questionnaire was divided into two sections. A habitat evaluation section included questions on major land uses in the stream basin, flow, bottom type, sedimentation, and water quality. If water quality was stated to be less than good, the respondent was asked to indicate why a fair or poor evaluation was given.

Fisheries support was evaluated through questions regarding stream fishery characterization, reproduction (as indicated by presence or absence of both young-of-year (y-o-y) and adult sport fishes), fishery success, and trend of the fishery over the last 10 years. If the fishery was felt to be poor, the respondent was asked to indicate why.

In this evaluation of use support, only those questionnaire responses indicating definite support or nonsupport were used. Partial support was not assessed. A stream was considered to fully support WAH use if:

(1) the stream supported a good fishery,
(2) both y-o-y and adult sport fishes were present, or if only y-o-y were present, the stream was a tributary to a stream supporting the WAH use, and
(3) water quality was judged good.

A stream did not support the WAH use if:

(1) the stream supported a poor fishery,
(2) few or no fish were present in the stream, and
(3) water quality was judged poor and/or repeated fish kills were known to occur.

The questionnaires proved useful in evaluating the support or nonsupport of use in streams. The concept of utilizing sport fishery information was adopted from the Illinois 1986 305(b) report. While the questionnaire was somewhat rudimentary, it was useful and helped to increase the number of assessed streams in the state.

Another source of data for the evaluated category was a list of streams recommended by the KDFWR as candidates for State Outstanding Resource Waters. They were recommended because of their outstanding value as sport fishing streams. These streams were assessed as fully supporting warmwater aquatic habitat use if there was no data which conflicted with the assessment.

Use Support Summary

Table 3 shows the results of the evaluated and monitored assessments on a statewide basis. The threatened category is a subset of the miles fully supporting uses. It refers to stream miles which were judged to be in danger of use impairment from anticipated land use changes, development of trends indicating possible impairment, or other data such as fish tissue contaminants which indicated a future problem.

Table 1 has more total assessed miles and more miles in the partial support category because it included conclusions from ORSANCO's assessment of the mainstem of the Ohio River and Missouri's assessment of the Mississippi River. Both tables followed EPA guidelines which defined fully supporting as meaning that all uses which were assessed had to be fully supporting before a segment could be listed under that title. If a segment supported one use, but did not support another, it was listed as not supporting. For instance, if a segment supported a warmwater aquatic habitat use, but not a primary contact recreation use, it was listed as not supporting. A segment would be listed as partially supporting if any assessed use fell into that category even if another use was fully supported. Many streams were assessed for only one use because data were not available to assess other uses.

Table 3

Summary of Assessed* Use Support

Degree of Use Support	Assessment Basis Evaluated	Monitored	Total Assessed
Miles Fully Supporting	4,521.7	1,653.5	6,175.2
Miles Threatened	399.0	320.4	
Miles Partially Supporting	493.1	385.4	878.5
Miles Not Supporting	446.9	1,151.9	1,598.8
TOTAL	5,461.7	3,190.8	8,652.5

*Excludes mainstems of Ohio and Mississippi rivers; refer to ORSANCO and Missouri 305(b) Reports for assessments.

Causes of Use Nonsupport

Table 4 indicates the relative causes of use nonsupport. Stream segment lengths which either did not support or partially supported uses were combined to indicate the miles that were affected. Fecal coliform bacteria were the greatest cause of use impairment and affected primary contact use in 969 miles of streams and rivers. Siltation was the second greatest cause of use impairment. It impaired warmwater aquatic habitat use in 723.7 miles of streams and rivers and moderately impacted a further 126.5 miles. Siltation affects the use by covering available habitat, preventing aquatic organisms which would normally live in the stream from inhabiting the area.

Sources of Use Nonsupport

Sources of use nonsupport were assessed under point and nonpoint categories and are listed in Table 5. Nonpoint sources as a whole affected about twice as many miles of streams as point sources. However, municipal point sources affected more miles of streams than any other source. Primary contact recreation was the major use impaired by municipal sources and was caused by fecal coliform pollution. Nonpoint sources, primarily surface mining and unspecified sources, impaired warmwater aquatic habitat use because of siltation.

Table 4

Relative Causes of Use Nonsupport
in Rivers and Streams

Cause Category	Miles Affected	
	Major Impact	Moderate/Minor Impact
Pathogens (fecal coliforms)	969.0	-
Siltation	723.7	126.5
Metals	369.9	124.8
Organic enrichment/D.O.	300.4	113.5
pH	184.7	-
Salinity (chlorides)	158.4	50.2
Priority organics	137.8	-
Unknown toxicity	118.0	10
Habitat modification	111.1	20.5
Nutrients	100.3	4.2
Oil and grease	37.3	-
Pesticides	27.5	-
Ammonia	-	2
Chlorine	-	2

- Not assessed